## OUR ASTRONOMICAL COLUMN

The Binary Star γ Virginis.—Dr. Doberck has recently determined the elements of this star from all the measures available up to the spring of the present year. He gives two orbits, the second of which represents the measures about the periastron-passage somewhat better than the first, but otherwise has no material advantage over it. Dr. Doberck points out that the part of the orbit most interesting to examine was described between the years 1839 and 1847, when the angle of position, after being very oblique, passed quickly through zero, without very much alteration of distance. He finds that the correction required by the angles observed by Dawes, who used a prism for the purpose of keeping the images of the stars apparently in the great circle passing through the zenith, did not much change; those of M. Otto Struve altered in a most pronounced manner; but he adds, "it is quite natural that the errors should be rather large in the case of these stars, which for most observers were at no great distance from the southern horizon, and which, in most telescopes, appear as large disks, at least when the state of the atmosphere is not exceptionally favourable." Dr. Doberck gives a separate comparison with the observations of the Pulkowa astronomer from 1840 to 1874 both as uncorrected and with the corrections in the "Observations de Poulkowa," vol. ix.; he finds that "the observed distances are improved by the corrections, except before 1843, when no corrections ought to be applied," and this is apparent from his investigations on the elements of other double-stars: the angles also are confirmatory, but would be better without the corrections as late as 1853. We subjoin Dr. Doberck's second orbit, and for the sake of comparison the orbit deduced by Thiele, after a very full discussion of the measures up to the year 1865, taken from his treatise published at Copenhagen in 1866.

| | Doberck. | Thiele. |
|---|---|---|
| Periastron passage ... ... ... | 1836·450 | ... 1836·685 |
| Node ... ... ... ... ... ... | 46° 0′ | ... 35° 35′ |
| Periastron from node on orbit (λ) | 273 55 | ... 283 44 |
| Inclination ... ... ... ... | 33 9 | ... 35 6 |
| Eccentricity ... ... ... ... | 0·89040 | ... 0·89575 |
| Semi-axis major ... ... ... | 3″·94 | ... 3″·97 |
| Period of revolution ... ... | 179·65 years | ... 185·01 years. |

We have added 180° to Dr. Doberck's element (λ), to accord with the angle as it was expressed by Dawes and most other observers until within a recent period, but there appears to be slight variation in the brightness of one of the components, as will be seen from an inspection of M. Otto Struve's observations in the Pulkowa volume referred to above.

The Transit of Mercury, November 8.—This is a phenomenon of which we must look for particulars from observers in Australia: it will be wholly invisible in Europe, the conjunction in R.A. taking place at 0h. 38m. a.m. Greenwich time. At the next transit on the morning of May 10, 1891, the egress only will be observable at Greenwich, the sun rising at 4h. 19m., and the last external contact occurring at 4h. 50m. The conditions are reversed in the following transit on November 10, 1894; the first external contact will take place at 3h. 55m. p.m., and the sun's upper limb will be in the horizon at 4h. 18m. This will be the last transit of Mercury in the present century.

Comet 1881 *f* (Denning).—M. Schulhof of Paris has found elliptical elements for this comet: the period assigned is 7¾ years, but is yet uncertain. A near approach to the orbit of the planet Jupiter is shown by M. Schulhof's ellipse in heliocentric longitude 219°·7, at which point the distance is only 0·18 of the earth's mean distance from the sun.

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## GEOGRAPHICAL NOTES

Mr. James Jackson, "Archiviste-Bibliothécaire" of the Paris Geographical Society, has published, in a volume of 340 pages, a "Liste Provisoire de Bibliographies Géographiques Spéciales." The list was undertaken at the instance of the Society, and was printed in some haste, we believe, for the recent Venice Congress. But when we remember that the list is only a bibliographical one, a list of lists, in fact, the accumulation of geographical literature is almost appalling. It bears evidence of extensive and careful research, though the author admits that it is by no means exhaustive. Mr. Jackson recently visited the United States to search the libraries there, and the result is a work invaluable to all students of geography. He has wisely devoted comparatively small space to Europe, because, as he states, the works relating to the countries of that continent are well known and easily accessible. Mr. Jackson gives not only bibliographies proper, but references to works on travel and geography, and to periodicals, journals, and transactions, which contain special lists. The divisions of the list are:—Europe, Asia, Africa, America, Oceania, Polar regions, Oceans and Hydrography, Peoples and Nations, Voyages, Travellers, and Geographers, and Generalities. By means of the arrangement under each division the methodical table of contents, the index to authors and periodical publications, the work is rendered easily consultable. It reflects the greatest credit on Mr. Jackson's industry, and on the enterprise of the Paris Society.

The only new paper in the Geographical Society's *Proceedings* is Mr. William Beardall's on his exploration of the Rufiji River under the orders of the Sultan of Zanzibar, which lasted from December 8, 1880, till February 19, 1881, and, we believe, was undertaken mainly at the suggestion of Sir John Kirk. A sketch map of the river accompanies the paper, on which the portion above Mpembeno, almost to E. long. 37°, is given from Mr. Beardall's surveys. The geographical notes furnish some particulars respecting the Italian Antarctic Expedition, Mr. Joseph Thomson's recent exploration of the Rovuma district of East Africa, and the American Missionary Expedition to the Bihé plateau in West Africa. There are obituary notices of the Visconde Duprat, the Rev. F. W. Holland, Major S. Anderson, R.E., Sir Vincent Eyre, and Col. T. G. Glover, all of whom had rendered more or less important services to geography.

Writing on a new map of the Dutch East Indies, about to be published at the Hague, the *Annales de l'extrême Orient* for October mentions that, besides its scientific value, this map is interesting from the adventures which have attended its production. The four stones which together form the lithograph were engraved for the most part in Java, the orography and the names alone remaining to be done in Europe. They were carefully packed and despatched to Holland by one of the Dutch mail steamers, but the latter unfortunately was wrecked, and the stones sank to the bottom of the sea. After much trouble the huge cases containing them were raised, and ultimately arrived at their destination. The new map is on a scale of 1 to 500,000, and is in three colours: the mountains in bistre, the seas, lakes, &c., blue, and the remainder in black. The leaves measure 218 centimetres by 78.

In an "occasional note" on Monday, the *Pall Mall Gazette* predicts a miscellaneous Arctic meeting for the opening of the Geographical Society's session on November 14. If this should prove correct, it is to be hoped that Capt. Gray may be induced to give some verbal information on his discovery that the Polar-pack was this summer six degrees nearer the shores of Europe than in 1879. Though the note in question is, no doubt, to some extent inspired, we believe the evening's programme is by no means finally decided upon. The subject on which the president, Lord Aberdare, in his address would most naturally dilate, would be his recent visit to Venice, in which case we may hope for an intelligent and intelligible account of the proceedings of the Geographical Congress. Hitherto we have heard of little but some effusive speeches and the showering of diplomas and medals on the foreign societies and individuals who took the trouble to send articles to the Exhibition.

With reference to the report that Mr. Gordon-Bennett is about to visit Dundee in order to purchase a whaler to be sent in search of the *Jeannette*, it is probable that this new expedition is the one which Lieut. Hovgaard, of the *Vega*, has volunteered to lead.

Capt. Meyer, of the German schooner *Phœnix*, at Callao, from San José de Guatemala, reports having discovered a new island. According to advices received by the West India Mail it is in lat. 7° 48′ S., long. 83° 48′ W., lying about 188 miles from Punta Aguja, which is the nearest land. The island appeared of volcanic origin, not being over fifty feet above the sea in its highest part. It is a mile long, and about the same width, and Her Majesty's ship *Kingfisher* and the United States vessel *Alaska* have been despatched to examine it. The Chilian transport *Chile* has also been ordered to pay it a visit during a trip she is now making to the North.

Mr. Joseph Thomson has returned to Zanzibar from a three months' exploration of the Loende tributary of the Rovuma

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River. Not a trace of coal was found along the whole course of the river, though it was reported by the natives to be seen in abundance protruding on the river banks. The whole country is thickly covered with wood. Mr. Thomson contemplates setting out on his second expedition during the present month. He intends to visit the little-known region between the sea and Mount Kilimanjaro, extending from Melinda on the north to Pangani on the south. Mr. Thomson hopes to make important discoveries in geology and botany.

A PRETTY full account of the proceedings of the recent International Geographical Congress at Venice will be found in the new *Bollettino* (for August) of the Italian Geographical Society, which reports in full the papers on the question of oscillations on the coast of Italy. It contains besides a map showing the various arcs of meridian and parallels that have been measured all over the world, and a map of Europe showing the present state of the various trigonometrical surveys in that continent. Russia, Turkey, and Greece are almost blank, and the Scandinavian peninsula is far behind; the other countries are shown covered with triangles.

## *LUNAR DISTURBANCE OF GRAVITY*[1]

IN November, 1878, Sir William Thomson suggested to Mr. G. H. Darwin that he should investigate, experimentally, the lunar disturbance of gravity and the question of the tidal yielding of the solid earth. This Committee of the British Association was subsequently reappointed, and the authors' names were added to the list of its members. In May, 1879, the authors visited Sir William Thomson at Glasgow, and there saw an instrument which, although roughly put together, he believed to contain the principle by which success might perhaps be attained. The instrument was erected in the physical laboratory of the University of Glasgow. The following are the rough details:—

A solid lead cylinder, weighing perhaps a pound or two, was suspended by a fine brass wire, about five feet in length, from the centre of the lintel or cross-beam of the solid stone gallows which is erected there for the purpose of pendulum experiments. A spike projected a little way out of the bottom of the cylindrical weight; a single silk fibre, several inches in length, was cemented to this spike, and the other end of the fibre was cemented to the edge of an ordinary galvanometer-mirror. A second silk fibre, of equal length, was cemented to the edge of the mirror, at a point near to the attachment of the former fibre. The other end of this second fibre was then attached to a support, which was connected with the base of the stone gallows. The support was so placed that it stood very near to the spike at the bottom of the pendulum, and the mirror thus hung by the bifilar suspension of two silks, which stood exceedingly near to one another in their upper parts.

It is obvious that a small displacement of the pendulum, in a direction perpendicular to the two silks, will cause the mirror to turn about a vertical axis.

A lamp and slit were arranged, as in a galvanometer, for exhibiting the movement of the mirror by means of the beam of light reflected from the mirror. It was found to be in incessant movement, of so irregular a character that it was hardly possible to localise the mean position of the spot of light on the screen, within five or six inches. On returning to the instrument after several hours, the observer frequently found that the light had wandered to quite a different part of the room, and it was sometimes necessary to search through nearly a semicircle before finding it again. The cause of this extreme irregularity of the movement of the pendulum was obscure; and as Sir William Thomson was of opinion that the instrument was well worthy of careful study, the authors determined to undertake a series of experiments at the Cavendish Laboratory at Cambridge.

Accordingly throughout 1880 they proceeded to make experiments with an instrument which involved the principle above explained. Several modifications of some importance were introduced. The pendulum was hung in fluid, in order to quickly destroy the oscillations generated by local tremors, and, being suspended by two wires, it was only free to oscillate in one direction, namely, the meridian. There was also introduced an apparatus, which we have not space to explain, by which a known very small horizontal thrust might be applied to the pendulum. By means of this the actual displacements of the pendulum were determinable from the observed displacements of the spot of light on the screen.

The image on the screen was found to be in a state of continual agitation of an irregular character, so that it was not possible to take a reading with very great accuracy. But as the pendulum was hung in fluid, the agitation was not nearly so great as it had been in the instrument at Glasgow.

The observers also found that the pendulum was subject to a diurnal oscillation, and that it stood furthest north towards 6 p.m., and furthest south towards 6 a.m. Superposed on this motion was a gradual change of the mean diurnal position, for during two months the pendulum moved northwards.

The instrument was found to exhibit the flexure of the stone piers of the gallows, even when the force employed was only a slight pressure with one finger. Water poured on the ground round the basement of the stone gallows tilted the whole structure over, and very small changes of temperature in the stone piers were found to give distinct effects. It was concluded that 1 foot of displacement in the spot of light on the scale corresponded with 1″ of change in the direction of the plumb-line with reference to the base of the gallows.

From these experiments the authors concluded that the instrument was susceptible of all the delicacy requisite, but that the mode of suspension was unsatisfactory.

Accordingly in 1881 they proceeded to erect a new instrument in which the support for the pendulum was a copper tube, which itself formed the envelope for containing the fluid in which the pendulum was suspended. The whole apparatus was immersed in a large mass of water, and the observations were taken from outside of the room by means of a telescope. The unsteadiness of the image was diminished, probably on account of the precautions taken against inequalities of temperature in various parts of the instrument, and because the pendulum was hung in a very confined space. The accuracy with which readings could be taken was thus increased.

Similar diurnal oscillations of the pendulum were again observed, and a similar slow change in the mean diurnal position. The authors therefore concluded that these changes are a real phenomenon, and do not depend upon changes of temperature in the instrument itself.

They also noted that there are periods lasting for several days in which the pendulum is in a state of continual agitation, so that the readings taken at a few seconds apart do not agree *inter se*, and that there are other periods of abnormal quiescence. These periods do not seem intimately connected with the external meteorological conditions, at least as far as the experiments have been hitherto carried.

The pendulum was found to be practically insensible to the effect of local tremors, such as are produced by hitting the stone support or stamping on the ground in the immediate neighbourhood of the instrument. But it was extraordinarily sensitive to steady forces. If a force be applied at a point on the floor a dimple is produced in consequence of the elastic yielding of the soil, and any object on the floor is slightly tilted towards the point where the force is applied. Now when a person stood in the room at sixteen feet away from the instrument, and again at seventeen feet, the difference was rendered distinctly evident between the amounts of inclination towards the point of pressure of the stone basement supporting the pendulum in the two cases.

Although no great pains had been taken to render the instrument as sensitive as possible, it was found that an alteration of the plumb-line through 1-100th of a second of arc was distinctly measurable.

The second part of the paper contains an account of the work of some of the previous observers on the same subject.

M. Zöllner's instrument, the "horizontal pendulum," is described. It does not appear that any extensive series of observations have been made with it.

An account of M. d'Abbadie's work is next given. He made his observations by means of reflections from a pool of mercury, and the site of his experiments was at Abbadia, near Hendaye, in the south of France. He found that there were periods of agitation and of quiescence in the mercury, apparently without reference to any perceptible external causes. There were also gradual changes of level extending over several months, and the

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[1] Report of the Committee, consisting of Mr. G. H. Darwin, Prof. Sir William Thomson, Prof. Tait, Prof. Grant, Dr. Siemens, Prof. Purser, Prof. G. Forbes, and Mr. Horace Darwin, appointed for the Measurement of the Lunar Disturbance of Gravity. Account of experiments by G. H. Darwin and H. Darwin, read at the British Association, York, September 1881.

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